

electricity in accordance with Weber's law had not yet been discovered. And if some one else takes this trouble, then he who considers himself a representative *κατ' ἐξοχήν* of the deductive method should applaud him, instead of charging him with impiety, even if the results of the inquiry should turn out to be inconvenient for the Icarus flight of speculation.

As Mr. Zöllner does not put himself forward as a mathematician—on the contrary, informs us on pages 426 and 427 of his book that the too frequent use of mathematics cramps the conscious activity of the understanding and is a convenient means of satisfying vanity; and besides, in many passages, constantly repeats his expression of contempt for those who think they can refute his speculations by pointing out mistakes in differentiation and integration—we ought not to judge him too severely in the matter of Weber's law. No doubt it is scarcely reasonable for one who thinks himself entitled to be shaky in his mathematics, to take upon himself to pronounce upon matters which can be decided by mathematical investigation only. His "Theory of Comets," which may surely be regarded as in his opinion a model specimen of how the right methods are to be employed, gives, besides this, other much more popular examples of the same peculiar way of using or not using deduction, examples the consideration of which may be reserved for another more suitable opportunity.

(To be continued.)

MOVEMENTS OF THE HERRING

THE mysterious disappearance of the body of herring which used to frequent Loch Fyne has directed renewed attention to the natural history of that fish. This is now the second time that the shoal of herrings which made Loch Fyne its *habitat* has deserted that celebrated sheet of water. No scientific opinion has yet been given as to the cause of this disappearance. A number of fishermen, resident on the Loch, say the herrings have been frightened away in consequence of persons fishing for them with a trawl net—which is, of course, nonsense; but not more nonsensical than the reasons assigned for the desertion by herring of other localities. As the so-called trawl-fishing of Loch Fyne (the net used is in reality a seine) was not in existence when the fish forsook the Loch on a former occasion, and were absent for a period of six years, the opinion of these men may be passed over as unworthy of serious consideration. Writers in the local newspapers, while inclined to favour the opinions of the drift-net men, that is, those who assert that the trawl-fishers have scared away the fish, also ask whether the spawning-beds may not have been in some way interfered with, and whether the body of fish frequenting the Loch may not from some unknown cause have departed before depositing their seed. If so, in what year would that occur? In other words, how long is it before the herring spawn of any given year comes to life, and at what period will the fish then born become reproductive?

These are events in the natural history of the herring, the dates of which have not yet been authoritatively settled. They are points, indeed, which have not yet been decided as regards any of our fish, except, perhaps, the salmon (*Salmo salar*), which has been nursed into life under a system that may be called artificial, that admitted of the young fish being watched, and their growth traced stage by stage, by means of certain signs and marks. It is thought that we may speak of the natural history of the salmon with more confidence than that of any of our other food-fishes. It is unfortunate that their studies of the natural history of the herring have not yet enabled naturalists to determine with exactitude how long it takes that fish to come to maturity.

Most varied opinions have been given on these points of herring life. Some persons have even gone the length of asserting that *Clupea harengus* and its congener *Clupea pilchardus* are able to perpetuate their kind within a year of their birth; even at the age of ten months! It has also been asserted that a herring is able to breed twice a year. Other opinions have been given, which assign to the herring a much longer period of growth, namely, that it requires from three to five years to reach maturity. Yarrell, again, and also Mitchell, think that it becomes reproductive in so short a period as eighteen months. What we may hold that we really do know is, that the eggs of the herring can be hatched within twenty days after their contact with the milt of the male fish. This has been proved by visiting the spawning places of the animals. On one visit all was spawn, everything that came in contact with the spawning-beds being covered with the seed of the herring; at the next visit, a fortnight after, the spawn was all gone; it had become vivified—and in proof of the fact, young herrings could in two or three weeks after be found in shallow places varying from an inch to two and even three inches in length. The probable time between the spawning of the fish and the fry reaching the dimensions named would be about forty days. How fast the young ones grow after that has not been authoritatively ascertained. It is thought, however, that if young herring reach the size of, say two-and-a-half inches, in forty days, it is not unreasonable to expect them to continue growing at the same ratio.

In the case of *Salmo salar*, the period necessary for the incubation of the egg has been determined beyond dispute. It ranges from 90 to 130 days. The growth of the young fish, after a time, if those who have watched it have not been deceived, is very rapid. At first, however, the salmon grows very slowly. A salmon hatched in March last may still be a very tiny animal, even after it is twelve months and in some cases two years old. In a year, however, it may be four or five inches long, and ready to migrate to the sea. There is a curious feature in the natural history of the salmon, the law of which has never yet been discovered—it is a riddle, in fact, even to the most scientific observers: only one half of the salmon of any particular hatching develop into what is called the *smolt*, or migratory stage, at the end of about twelve or fifteen months from the time of their being hatched. The other moiety of the brood does not seek the sea or take on the migratory dress till the expiry of a little over two years from the time of birth! One half of the fish, therefore, will at one and the same time be tiny creatures, about three inches long, whilst the other moiety will be five inches in length, and of corresponding girth; but these dimensions, it must be confessed, show no great rapidity of growth. Indeed, it is not till after the salmon proceeds to the sea that its growth becomes at all rapid; but, notwithstanding this rapidity, it must, we think, be a considerable number of years before a salmon can attain to the weight of fifty or sixty pounds; although the smolt, it is affirmed by those who have watched it, returns as a grilse to its native waters in about three months, its size and weight being very largely increased.

The herring, as we all know, is a fish that never attains to any great size, and the weight of which may be counted in ounces. The question to be answered is this: Do small fish grow to maturity quicker than large ones? It has been asserted, in some quarters, that the herring grows quite as rapidly as the smolt does after it reaches the salt water, and the rate of growth there appears magical, when contrasted with its slow progress during the first year of its existence, or it may be, as has been already explained, the first two years. We are not, however, without a certain kind of proof of the rate at which the herring grows, which is better than reasoning analogically. It is quite fair to conclude that if herrings attain a size of about three inches within forty days or so of their birth,

they will attain their full dimensions within a year. It is known of herring, by means of personal observation, that from the time the roe or milt begins to develop itself, that is, when they become *maties*, no very long time elapses till they are ready to spawn: ten weeks has been estimated as about the time the herring takes to grow from a "matie," or fat fish, to a spawning herring.

The most contradictory accounts of the time at which herrings spawn have been published by various inquirers. Much of this confusion results, no doubt, from the fact that the herring is somewhere engaged in fulfilling this function of its life during nearly every month of the year. There are, it is thought, distinct races of this fish constantly coming to maturity and spawning at suitable times with the instinct of keeping up the breed. Thus, at Wick, on the Caithness coast, where there is still a great fishery carried on, although it is evidently now on the wane, herrings came to maturity and were ready to spawn in July. At one time large numbers of these (July) herrings were caught; indeed, some economists say too many were caught, and that in consequence the reproductive strength of the shoal was so impaired, or its economy so deranged, that it became exhausted. At any rate, few herrings are now taken in July at Wick. The great August shoal is being also over-fished, and symptoms are not wanting in the violent fluctuations which occur in the "takes," that it too will in time become unproductive. Herrings are found in the Firth of Forth ready to shed their spawn in the months of December, January, and February, and during these months young herrings and sprats (*Clupea sprattus*), are found mixed in the shoals which are fished at that period of the year. The question of where these schools of young fish go to whilst they are growing naturally presents itself. But who can answer it? The theory of the migration of the herring from and to the seas within the arctic circle has been long exploded, it having been established, it was thought, beyond cavil, that it is a native of our own seas: at all events, that it comes close to certain parts of the British sea-coasts to deposit its spawn. It is at that period of its life that we become familiar with the herring, and that is the time at which it can be most economically captured. Herrings are seen at that period of their lives in prodigious numbers; in fact, they lie in tiers on a favourite spawning ground, covering several square miles of sea-bottom. If all the parks of London were united together into one great space of ground, it would not nearly represent the width and length of a shoal of herrings engaged in spawning!

It has been asserted that herrings aggregate and segregate, but proof of this fact in their natural history is lacking. Almost immediately after the spawn has ripened into life, the tiny herrings are seen crowding together on the most shallow places of the coast, where they are safe from the attacks of larger fish, which would assuredly prey upon them if they frequented the deeper water. Now, if these fish separate, when do they do so? because, if they come to maturity, as is said, within a year, they have little time to live apart. If they go out to sea, how far do they go? It is a fact that at the time they are caught they are at first taken at a considerable distance from land. The writer has been out as far as twenty-five miles from the shore without finding a trace of the shoal; but within ten days or so the fish were found within a radius of ten miles of the port from which he had sailed in search of them, and they gradually came nearer and nearer, being often caught within two miles of the land. Although the fish of particular localities have such distinctive marks upon them as to render it easy to distinguish them, certain persons have again mooted the idea of the herring being a migratory animal, and that a great fish-shoal travels from the north to the south. A writer in a recent number of the *Scotsman* newspaper speaks of a vast shoal of herrings having arrived at

Wick, then of its passing Fraserburgh and Peterhead; next, of its being found at Dunbar and Eyemouth; then on the coast of Northumberland; and finally, he tells us, it will be found at Yarmouth, on the coast of Norfolk! What else is this but a revival of a portion of the old myth? The shoal must be constantly finding out new places to visit, and must also be deserting places where it used to call; it must also tell off brigades to spawn at different localities; otherwise, all that we have learned about the natural history of the herring during the last few years is imaginary. Any novice, almost, could distinguish a herring taken from Loch Fyne, when placed side by side with a herring caught off the bay of Wick. Fraserburgh, one of the places cited by the writer in the *Scotsman*, has only risen to importance as a herring port within the last ten years; close upon seven hundred boats were this year engaged in the fishery, whilst in 1864 there was not much above a fourth of that number. At Fraserburgh, and two or three little fishing stations which adjoin it, 181,000 crans of herrings were captured this year, and these fish would be of the value of about 300,000*l.* The capture by the boats fishing from Peterhead—also on the Aberdeenshire coast—this season would not be of less value than a quarter of a million pounds sterling. But whilst these Aberdeenshire ports are rising into notice as great centres of the herring fishery, other ports are declining. Wick, which used to be the capital of herring fishery enterprise, is now on the decline as a curing station. Why? For the simple reason, it may be presumed, that the owners of boats do not find it profitable to fish at that port. At one time as many as 1,200 boats used to fish for the Wick curers, but the number at work this year was five hundred less! Such a falling off is very striking, and goes a long way to prove that it is possible to "over-fish" the herring, or at least so to derange the economy of the shoals as to render them in time unproductive. It is only reasonable to argue that with the largely augmented drifts of nets increased quantities of herring ought to be captured, but it is being annually demonstrated that such is not the case, and that to keep up present supplies and provide for the supply demanded by an exigent and increasing population, more boats and still more extensive drifts of nets are required.

Even very young fishermen have seen the rise and decline of important seats of the herring fishery, apparently from the over-fishing or derangement of the shoals. It will be instructive to note what occurs in future to the Wick fishery, because, only a few years ago, it was the greatest herring-curing station in the world, whilst next year there is every probability of its being only a fourth-rate fishing port. The fishermen will naturally go where they can take their prey with the least possible trouble, and where the fishery is more regular than it has been during late years at Wick, where most of the fish have been taken by a few of the more fortunate fishermen, and many of the boats had to return morning after morning "clean." The boats fishing at Fraserburgh this year took each an average of 220 crans of herrings, and all of them were tolerably well fished; whilst the Wick boats only averaged ninety-four crans, the fishing being even more partial than usual. The further development of the fishery at Fraserburgh, Aberdeen, and Peterhead, which extends over a space of about forty miles, will be anxiously watched. The shoal or shoals which are yielding such wealth to the fishermen of these ports must be prodigious in size and wonderfully productive; let us take note how long they last, and keep a correct tale of what they yield. The run upon them for the next two or three years will only be limited by the accommodation which the harbours can give to the boats and the ground which can be allotted to the curers. The movements of the herring become yearly more interesting, and we cannot be too well informed in regard to them.